FLUORESCENT LIGHTING

By ROSELLA HORINE, ENGR. I

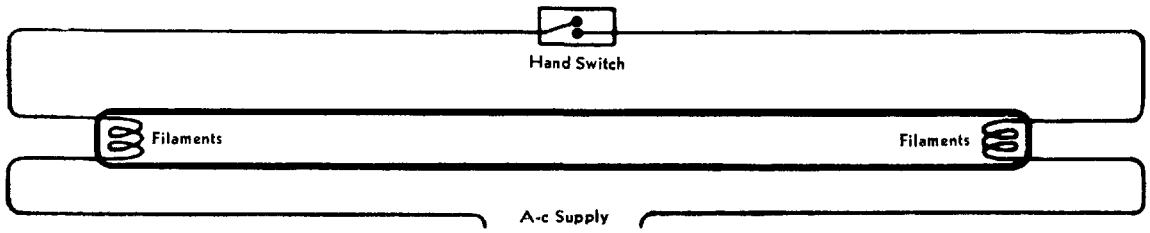
NOT unlike the evolution of the modern automobile from the buggy and the horseless carriage, fluorescent lights are replacing incandescent lamps; man progressed to the place where he substituted an electric light bulb in the place of a group of candles; over a period of years, improvements were made until an entirely new type of lighting evolved—the fluorescent lamp.

The fluorescent lamp consists essentially of a long cylindrical glass tube containing a tiny drop of mercury and a small amount of argon gas. Two small tungsten filaments, one at each end of the tube, start the ionization of the mercury vapor, at the introduction of the electric current, the argon generates sufficient heat to vaporize the mercury, which immediately begins carrying the current. Electrons, passing through the mercury vapor, cause it to become luminescent. This light, mixed with the light emitted by fluorescent chemicals which coat the inner surface of the glass tube illuminated by certain invisible ultraviolet rays given off by the mercury, is fluorescent light. Different chemical coats in the tube produce different colors of light.

This new lighting is rapidly gaining popularity; from 1938 to 1942 the sale of bulbs rose from two million to thirty million units. It has so many advantages over the incandescent lamp that after the war when production is resumed for civilian use the decoration of the American home will undergo a radical change in lighting. The fluorescent bulb life is about 2500 hours, compared to 1000 hours for the average incandescent lamp. Because it operates at a temperature of 100° to 120° Fahrenheit rather than the usual 260° to 400° Fahrenheit of incandescent bulbs, it helps in both conserving electrical energy and affords less competition for air conditioning systems. Its long cylindrical tube contains ten times the surface area of a comparable Edison bulb, enabling it to expel more light per unit area and to distribute it more evenly over this area. Thus, this diffused lighting will improve reading and working conditions. Correctly installed lights speed up defense production, eliminating glare and maintaining a firm distribution of light while helping the worker speed up his production work in a maximum amount of safety.

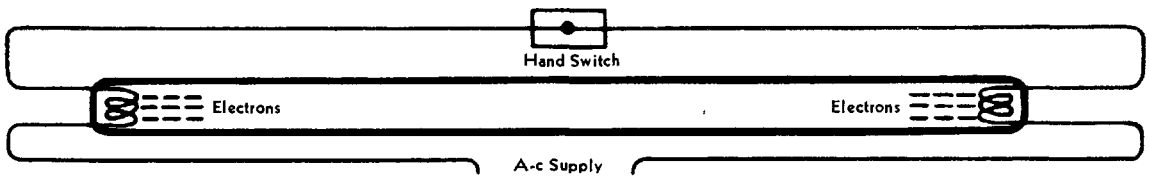
It looks as if fluorescent lights are here, and here to stay; but Mr. Average American will have to wait until after the war to test it for himself.

1



A fluorescent lamp consists of a glass tube, with a tiny drop of mercury and a small amount of argon gas in it. At each end there's a filament, so designed that it emits electrons freely when heated. The lamp is connected to a supply of a-c electricity in such a manner that, in simplified form, the circuit looks like the sketch above.

2



If the switch is closed momentarily, electricity flows through the filaments of both ends of the tube. This flow of electricity heats up the filaments and causes them to emit electrons as shown in the above sketch.

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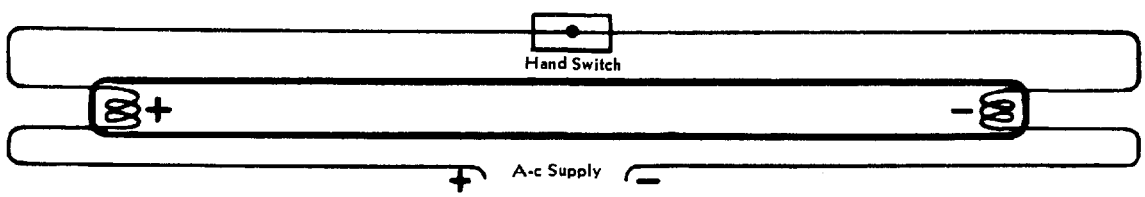

The alternating current changes its direction of flow many times a second. Thus, at any given moment in the a-c cycle, one of the filaments has a positive polarity while the other filament is negative.

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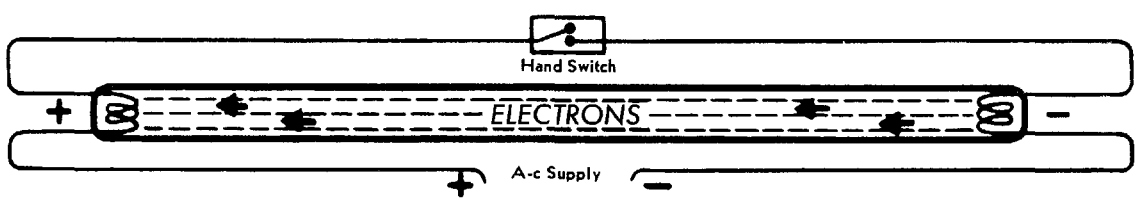
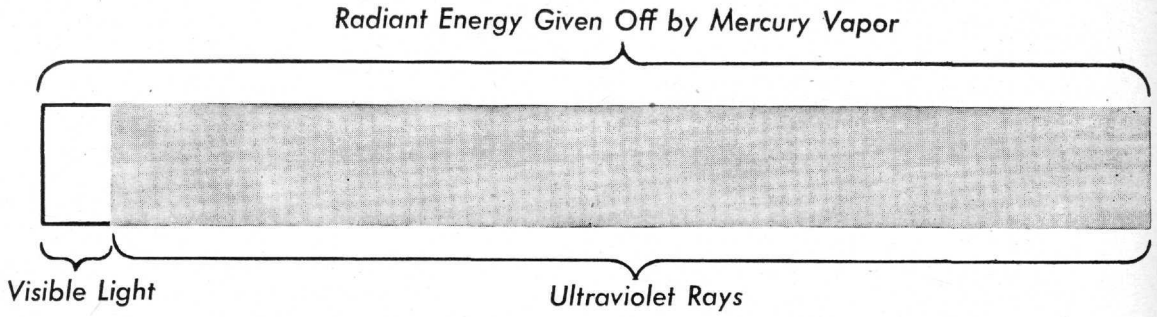


The argon gas in the tube conducts electricity at relatively low voltages; hence, if the switch is now open, the electrons emitted by a negative filament are attracted across this argon path to the other, or positive, filament, setting up an electric current through the tube. This current, in passing through the argon gas, generates sufficient heat to vaporize the tiny drop of mercury; the mercury vapor also conducts electricity from one end of the tube to the other.

5

The bombardment of the filaments by electrons coming from the other end of the tube heats up the filaments sufficiently to cause them to emit electrons without the need of the original starting current. This heating of the filaments causes them to emit more electrons, which cause more heating, and so on, the current flowing back and forth through the tube as the alternating current changes its direction. Here, of course, they are shown flowing one way only.

6



When the mercury is vaporized, the electrons passing through the vapor cause it to become luminescent. A considerable portion of the radiant energy thus given off is concentrated in very small bands of light of a definite wavelength. Some of this light is visible, but most of it is invisible ultraviolet rays, as this sketch illustrates.

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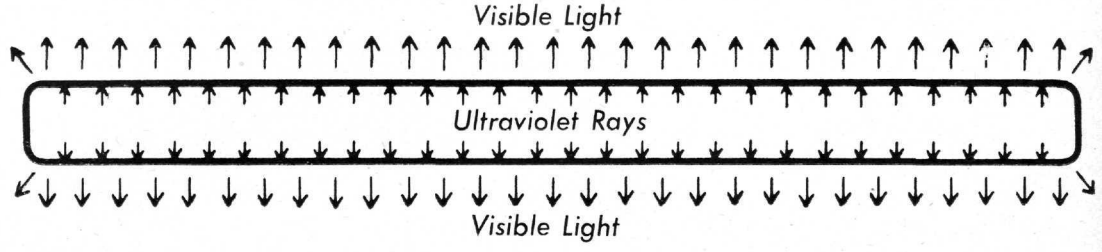

The inner surface of the glass tube is coated with fluorescent chemicals which have the property of absorbing the invisible ultraviolet energy given off by the mercury vapor and reradiating it as visible wavelengths. This is the bright light we see when the tube is in normal operation. Various fluorescent chemicals can be chosen to give different colors.

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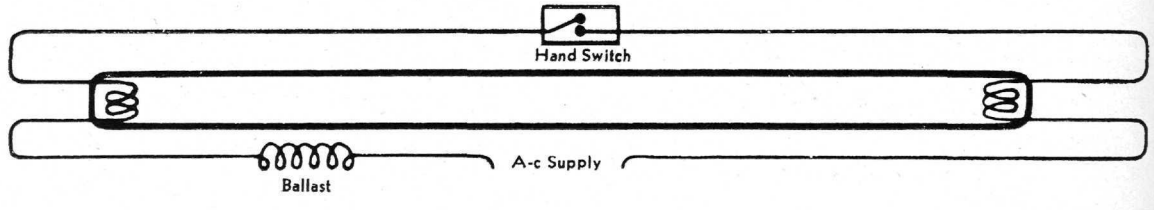

Such a circuit, however, still would not operate satisfactorily, because (1) the flow of current through the gas decreases the resistance of the gas, permiting more current to flow; (2) the increased flow of current decreases the resistance still more, and so on; (3) such a continued increase in current flow would quickly be equivalent to a short circuit and destroy the tube. So something must be done to prevent this. By inserting a choke coil or "ballast" in series with one side of the a-c supply, any decrease of resistance in the tube itself is automatically compensated for by a corresponding increase in the "resistance" of the ballast (because the "resistance" of the ballast increases as the current increases). Thus the ballast serves as an automatic regulator to maintain the amount of current flowing through the tube at a constant, predetermined value.

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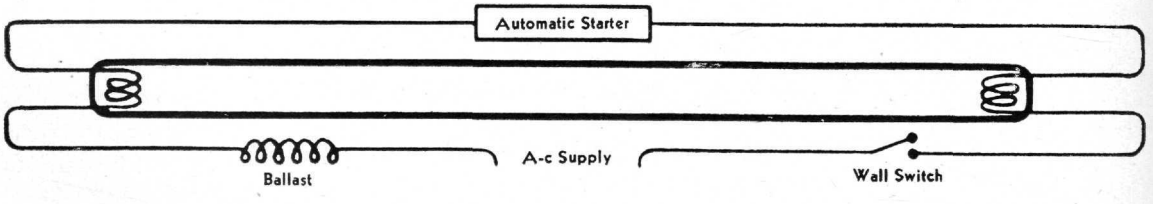

Actually, instead of starting the operation of the tube by means of a hand switch, an automatic starter is used. After the filaments are heated up by the bombardment of electrons, the automatic switch opens, for the current it controlled is no longer needed—and current wouldn't flow through the tube, furthermore, when it could take the easier path through the starting switch. The sketch above shows a typical fluorescent circuit in simplified form, with a wall switch for turning the lamp on or off.

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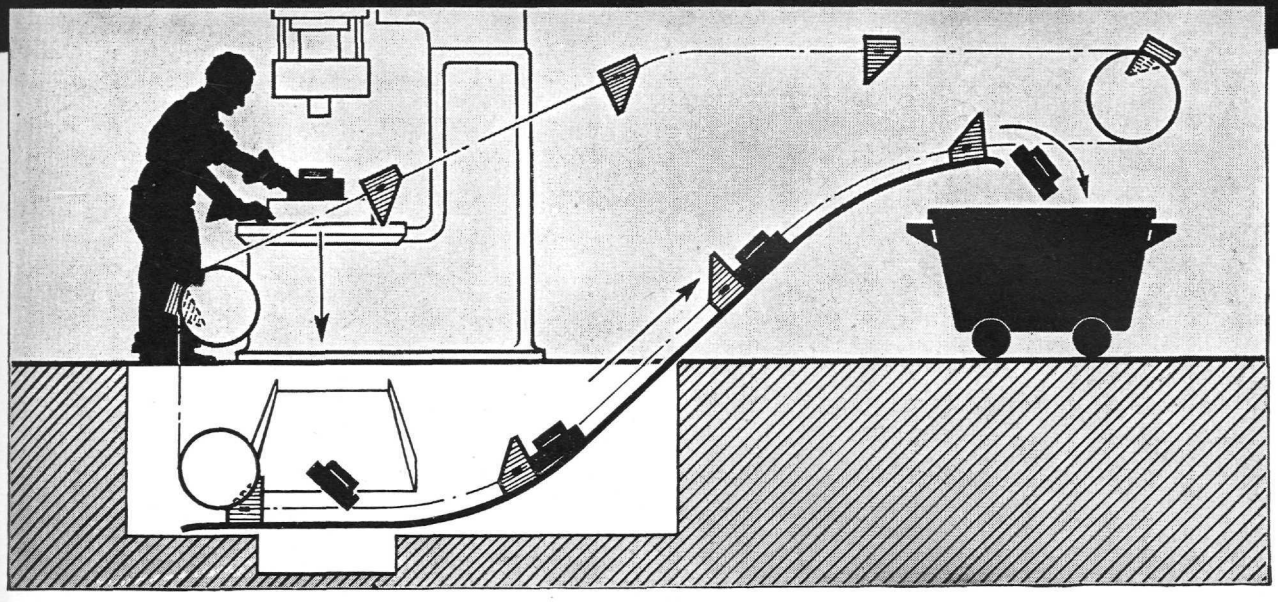

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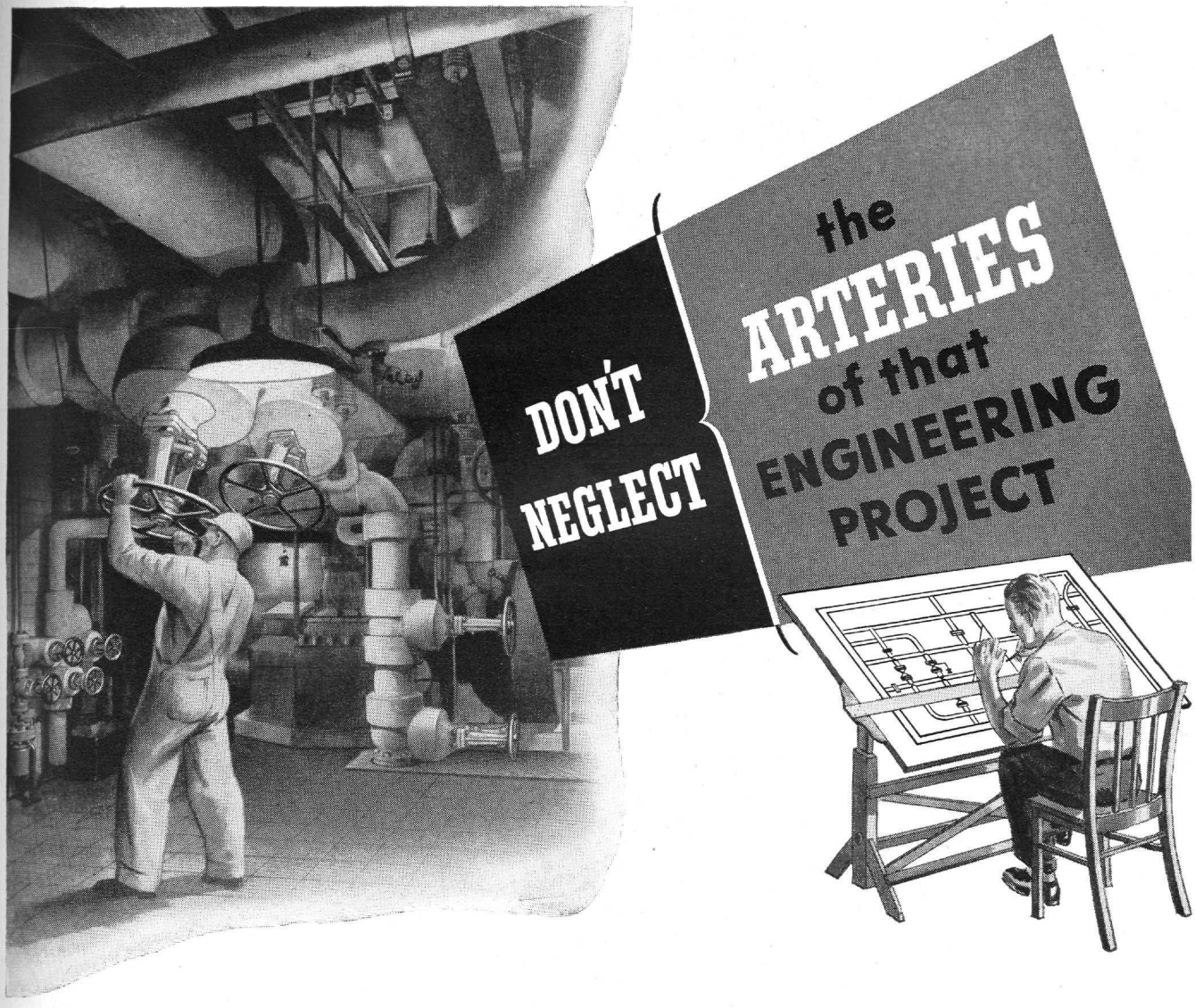

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